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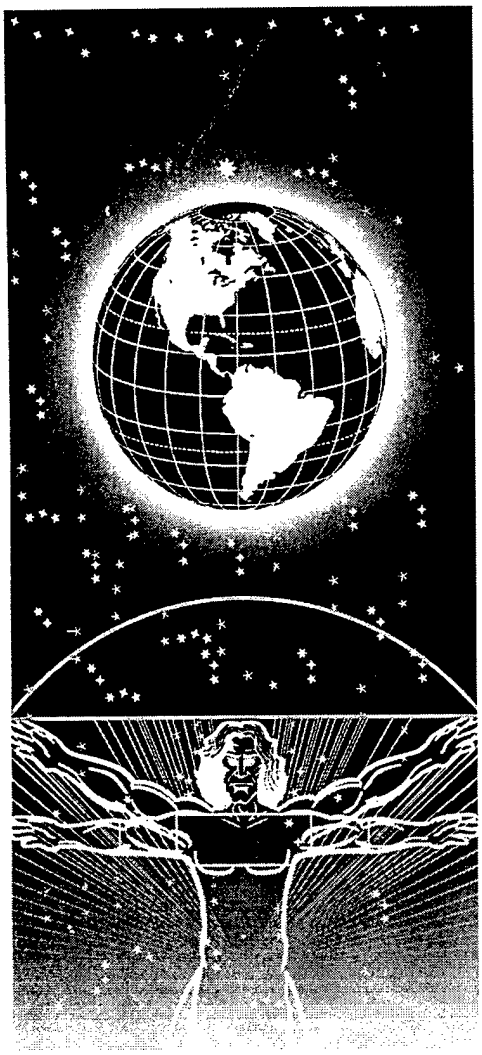

UNITED STATES AIR FORCE ARMSTRONG LABORATORY

COMPUTER-BASED JOB AND OCCUPATIONAL DATA COLLECTION METHODS: FEASIBILITY STUDY

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The Office of Public Affairs has reviewed this report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

This report has been reviewed and is approved for publication.

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13. ABSTRACT (Maximum 200 words)

This report documents the process and results from a feasibility study and evaluation of computer-based occupational data collection. The study was accomplished the Air Force Occupational Measurement Squadron in collaboration with the Human Resources Directorate of the Armstrong Laboratory and the Royal Australian Air Force. The feasibility study was conducted to assess the operational and logistical problems involved with the development, implementation, and evaluation of computer-based job and occupational data collection methods. This study included an evaluation of the quality and functional equivalence of the computer-based survey data versus traditional paper-and-pencil (scanable) forms, the availability of needed computer equipment in the field, and an assessment of the costs and logistics involved with disk-based mail out surveying. Two Air Force specialties (Information Management and Aircraft Fuel Systems) were included in the study; each AFS was sampled for 1,000 cases plus 50 task difficulty and 50 training emphasis factor ratings. While some problems were encountered in the study, particularly with the task factor rating data collection, final job inventory return rates of computer-disk surveys were quite comparable to paper-and-pencil forms. Analysis of the task information for both AFSs indicated that computer-based survey respondents tended to systematically check and rate more tasks, a result expected from previous research. Analysis of overall group job descriptions revealed few differences in percent members performing (PMP) or relative percent time spent (PTS) rankings. Correlations between paper-and-pencil and computer-based sample group mean vectors were in the high 90's for PMP and PTS factors as well as for the rank ordering of tasks on these factors. Overall, computer-based occupational surveys appear to be comparable, feasible, and economical.

14. SUBJECT TERMS

Comprehensive Occupational Data Analysis Program (CODAP); computer-based surveys; cost analysis; data collection methods; new survey technology; occupational analysis; paper-and-pencil surveys

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ACRONYMS

AETC	Air Education and Training Command
AF	Air Force
AFHRL	Air Force Human Resources Laboratory
AFMPC	Air Force Military Personnel Center (now AFPC; see below)
AFOMS	Air Force Occupational Measurement Squadron
AFPC	Air Force Personnel Center
AFS	Air Force Specialty
AI	Artificial Intelligence
AL	Armstrong Laboratory
AL/HR	Human Resources Directorate of AL (formerly AFHRL)
AOSP	Army Occupational Survey Program (now ODARS; see below)
ARI	Army Research Institute
ASC	Assessment Systems Corporation
ASCII	American Standard Code for Information Interchange
CODAP	Comprehensive Occupational Data Analysis Programs
CONUS	Continental United States
DOS	Disk Operating System
F-JAS	Fleishman Job Analysis System
Gb	Gigabyte (1,073,741,824 characters)
IBM	International Business Machine
IJOA	Institute for Job and Occupational Analysis
Kb	Kilobyte (1,024 characters)
MAJCOM	Major Air Command
Mb	Megabyte (1,048,576 characters)
MPT	Manpower, Personnel and Training
MVS	Multiple Virtual Storage (IBM trademark)
ODARS	Occupational Data Analysis, Requirements and Structure
OJT	On-the-job training
OPR	Office of Primary Responsibility
PACAF	Pacific Air Forces
PAQ	Position Analysis Questionnaire
PC	Personal Computer
PMPQ	Professional Manager's Position Questionnaire
RAM	Random Access Memory
RISC	Reduced Instruction Set Computer
SCM	Survey Control Monitor
SME	Subject-matter expert
SOW	Statement of Work
TD	Task Learning Difficulty
TE	Training Emphasis
TIARA	Task Inventory Analysis Requirements Application
UAR	Uniform Airman Record
UOR	Uniform Officer Record

USAFE	United States Air Forces, Europe
USAFOMC	United States Air Force Occupational Measurement Center (now AFOMS; see above)
USCG	United States Coast Guard
VM	Virtual Machine (IBM trademark)
Word	Microsoft Word (word processor)
WP51	WordPerfect Version 5.1 (word processor)

PREFACE

This report documents the process and results from a feasibility study and evaluation of computer-based occupational data collection. The study described herein was accomplished for the Air Force Occupational Measurement Squadron in collaboration with the Human Resources Directorate of the Armstrong Laboratory and the Royal Australian Air Force. The feasibility study was conducted to assess the operational and logistical problems involved with the development, implementation, and evaluation of computer-based job and occupational data collection methods.

Earlier versions of this paper were presented at International Military Testing Association conferences in 1994, 1995, and 1997. We gratefully acknowledge the technical support provided by the Air Force Occupational Measurement Squadron. We also acknowledge the critical role the Air Force Career Field Managers of the specialists used in this study played in its successful completion.

Introduction and Overview

Introduction

The Air Force has been studying the possibility of automating administration of occupational surveys (Albert, Phalen, Selander, Yadrick, Weissmuller, Dittmar & Tucker, 1993; Albert, Phalen, Selander, Dittmar, Tucker, Hand Weissmuller & Rouse, 1994). Preliminary results from experimental studies suggested that the use of computers for occupational surveys was highly possible and the quality and reliability of data collected might be substantially improved (Mitchell, Weissmuller, Bennett, Agee, & Albert, 1995; Phalen & Mitchell, 1996). A field study, conducted in 1994 and 1995, examined the feasibility of computer-based survey administration using Air Force-developed software and normal operational administration procedures.

This report documents a feasibility study conducted by the Institute for Job and Occupational Analysis (IJOA) for the Occupational Survey Branch of the Air Force Occupational Measurement Squadron (AFOMS/OMY) in collaboration with the Human Resources Directorate of the Armstrong Laboratory and the Royal Australian Air Force. The objectives of this study were to conduct a feasibility study of the development, implementation, and evaluation of computer-based job and occupational data collection methods. The study included an evaluation of the quality of the data obtained from both a paper-and-pencil occupational inventory and a computer-based version of the same inventory. Additionally, the study assessed the impact of logistics associated with automating the process -- not with the particular software employed. Finally, the study projected costs and schedules for automated surveys based on the observed ease of deployment in this study and identified implementation issues which may be associated with computer-based development and delivery systems.

Specific objectives of the study were as follows:

(1) Develop a detailed feasibility study and analysis plan;

(2) Conduct and document a critical review of existing computer survey capabilities and commercial products:

   a. Conduct a review of Air Force bases and Survey Control Monitors (SCMs); this review included contacting bases in the continental United States, Pacific Air Forces (PACAF), and United States Air Forces, Europe (USAFE) to determine the extent and capabilities of available computer resources to support data collection.

   b. Review existing commercial job, occupational, and position analysis methods and recommend a method for use in the feasibility study. For this review, criteria such as cost of obtaining each method, proprietary restrictions on the use of the method, capacity of the method to accept AF task lists, size of the program for data collection (i.e., desired method shall

include execution and data collection on a single International Business Machines/Personal Computer (IBM/PC)-compatible diskette for each survey type), ease of data collection and transfer to a larger data file, and the capability of the method to collect job and occupational data from respondents using available PC-size computers, not merely to score data obtained from a scanable sheet or from other non-electronic media.

(3) Identify two AF specialties (AFSs) for which paper-and-pencil occupational inventories have been developed and fielded. These AFSs will serve as the candidate AFSs for the development and feasibility test of the computer-based method.

(4) Review and debug the computer-based versions of the job inventory and the task factor survey for each AFS. AL/HR researchers will develop versions of each survey and provide them to AFOMS for use in the project. Development activities include:

a. Downloading each AFS task list from the AFOMS computer, and

b. Configuring cover pages, respondent instruction, and task lists to approximate the paper-and-pencil version of the inventory for delivery and data collection of each different type of survey on a single diskette, and using a unique survey control number convention to enable computer-based survey to be distinguished from the paper-and-pencil survey data.

(5) Select equivalent random samples of field personnel to receive the computer-administered and paper-and-pencil surveys. AFOMS distributed the computer-based versions to field personnel identified in the sample using their established occupational survey distribution process.

(6) Apply criteria for the feasibility test and evaluation of the computer-based method and the traditional paper-and-pencil method and associated data. These criteria included:

a. Document costs associated with:

(1) development (e.g., time and materials),
(2) delivery (e.g., mailing, time, and materials),
(3) data retrieval and use,

b. Identify logistics issues and constraints:

(1) distribution to any work location,
(2) printing,
(3) disk copying,
(4) computer availability in the field,

(5) ease of computer use by respondents, and
(6) ease of data aggregation from single inventory to aggregate data files and from single diskette to aggregate data file.

c. Assess data quality

(1) return rates,
(2) representativeness of data from respondents using both methods, group membership, comparable cases, diagram, and
(3) interrater agreement of responses, and comparable background data.

d. Compare specific data elements for each survey type

(1) time spent ratings,
(2) percent members performing task ratings, and
(3) task factor data (task difficulty and training emphasis ratings).

e. Gather user responses related to surveys

(1) reactions to using the computer-based survey method compared to paper-and-pencil methods,
(2) ease of survey response by users of both,
(3) convenience of survey approach and data collection, and
(4) availability of various levels of computer technology (disk drive size, mouse, color monitor, etc.).

Returned diskettes were forwarded from AFOMS to IJOA (as the complete data files developed from the paper-and-pencil inventory responses). IJOA performed virus checking and data aggregation for diskette surveys and subsequently compared the data obtained from each type of inventory.

(7) Provide a final report documenting the study results and recommendations of this work to the Air Force.

Technology Review

Review of the Literature

Previously when conducting surveys using a computer for administration, specialized computer skills and expensive computer equipment were required. However, now, with the increasing sophistication in the personal computer arena, computer administered surveys in organizational settings are becoming a favorable alternative. Rosenfeld, Booth-Kewley, and Edwards, 1993, list four advantages to administering a computer survey: 1) survey data entry is automated, 2) missing data can be eliminated, 3) there are no out-of-range responses, and 4) complex item branching, transparent to the respondent, can be used. Because the survey data are automated, the chance for errors to occur during data collection or data analysis is minimal. Also, processing time for data analysis is greatly reduced (Rosenfeld, et al, 1993). The logistic and technical requirements of large-scale paper surveys typically require a year or more from start to finish. Therefore, the findings are often outdated by the time they are obtained (Edwards, Rosenfeld, Booth-Kewley, & Thomas, 1996).

Most of the comparative reviews of job analysis methods (e.g., McCormick, 1979; Gael, 1988; and Levine, 1983) do not include any information on computer-based surveying systems. A recent survey of job and occupational analysts in Australia, Canada, and the United States indicates that computer-based surveying is among their highest priority interests for near-term research and development (Fugill & Weissmuller, 1993).

Computers are often used for analysis of data. The data are typically scanned from optical or mark-sensitive score sheets. Data may also be used for interfacing with a cumulative database or set of norms, as with the PAQ/PMPQ Enter-Act system (PAQ Services, 1990). This permits a generation of norm-based individual and group analysis reports. Other job analysis systems, such as the Fleishman Job Analysis System (F-JAS), use scanable score sheets and suggest that computer administration will be developed sometime in the future (Fleishman & Reilly, 1992).

The most recent comprehensive review of job analysis (Harvey, 1991, 71-163) highlights the need for development of computer administration for job analysis functions. Harvey (1991) indicates, that part of the resistance to the collection of needed comprehensive task information has been the relative high cost of such data collection. Harvey suggests that "advances in computer hardware and software technology hold the promise of significantly reducing the cost and labor-intensiveness of this approach to job analysis" (p. 117). Harvey also notes that:

> Today desktop personal computers costing under $10,000 can match the performance of the million-dollar mainframe systems that only 15 years ago were required to run programs like CODAP. Thus, the computing power required to manage job analysis data bases is within the reach of even the smallest organization. Efforts to develop computerized integrated personnel systems (IPS) have increased dramatically in recent years (e.g., Avner & Mayer, 1986; Harvey, 1986; Mitchell & Driskill, 1986; Wilson, 1987).

> Although computerized integrated personnel systems can make the process of managing and using large amounts of task-based job analysis data practical for both large and small organizations, the problem of collecting the task information remains (Harvey, 1991, 117).

Harvey (1991) recommends the development of Artificial Intelligence (AI-based systems to assist in the development of task inventories and other job-related information. He reports the development of job analysis computer software by Wilson (1991) for capturing ability requirements ratings, which presumably would use a single standardized task list. Wilson indicates he used an AI shell to capture raters' responses to a set of questions; he found it took about the same amount of time as traditional paper-and-pencil ratings, but that respondents seemed to prefer the computer administration (Mark Wilson, personal communication, 24 May 1994). Wilson & Zalewski (1994, p. 200) note that "we find it surprising that little research has focused on the application of expert system technology to collecting information about jobs (job analysis)."

Harvey (1991) recommends an "alternative approach" for reducing the cost of collecting detailed task information through use of a "generic task inventory" for broad "occupational categories (e.g., clerical, managerial, etc.)" based on a synthesis of prior job analysis research (Harvey, 1991). He concludes his discussion of this area with the comment:

> Although standardized, worker-oriented questionnaires are useful for many personnel functions, there are some applications of job analysis data, such as development of training programs, that can only be solved with task-oriented job analysis data: Making such methods cost effective is a critical goal (Harvey, 1991, p. 118).

In an effort to determine the differences between computer and paper-and-pencil administration of noncognitive measures, Potosky, and Bobko (1997), looked at the redesign of the system to select Air Traffic Controller Specialists (ATCS) in the United States, for the Federal Aviation Administration (FAA). Interested applicants took both a computer and paper-and-pencil version of the ATCS selection measures. This study indicated that for the empirical (raw) cross-mode correlations were greater than .90, and the estimated latent cross-mode correlations were all 1.0. This suggests that one can administer these noncognitive measures by means of computer with considerable confidence (Potosky & Bobko, 1997).

Telephone surveys also have been enhanced through the use of computer-assisted telephone interviewing (CATI) systems. The CATI system operates by allowing the computer to control the correct order, and branching of the questions when necessary. The CATI issues error messages when responses are out of range, and stores the responses in a data base for future data analysis (Edwards, et al, 1993). This system has provided gains in efficiency and error reduction.

This literature review indicates computer administered survey techniques are a becoming of increasing interest due to the benefits of time, cost, and reduction of administration and

analysis errors. Mitchell, et al (1994), indicate also that "respondents appear to have little if any difficulty completing the surveys on PCs, and their attitudes are for the most part extremely positive." During computer administration, disks can be produced faster and a considerable cost savings when compared to precision-printed optically scanable forms. In order to possibly see these discussed advantages one should consider using computer assisted techniques for job and occupational data collection methods if feasible for the particular task at hand.

Review of Available Commercial Software

For maximum flexibility, to avoid licensing issues and the payment of royalties, it was considered desirable to use government-developed and -owned software. Unfortunately, at the outset of this project, all candidate government systems were "research tools" rather than certified occupational survey engines. With that in mind, a temporary license of a commercial product was considered a possibility, especially if one wanted to guarantee a stable product where software bugs would not disrupt return rates used to evaluate overall automated logistics.

One of the problems with use of commercial systems is the license agreement which sets out fees and restrictions on use. Commercial software systems are protected by copyright laws and cannot be used except in accordance with permissions of the copyright holder and use incurs a "per-use" or site license fees. This limits the desirability of commercial software for widespread Air Force use or for transfer to other AF organizations for use in small, specialized applications.

Another of the problems with use of commercial systems is the fact that one cannot modify (adapt) a proprietary system. Should a commercial product closely meet the Air Force's needs, it may be more cost effective to obtain source code and unlimited rights from the commercial firm. While this is a possibility, it is important to remember that the present study sought to elaborate logistical issues in automated surveying and was not aimed at selecting an automated product.

Four commercial products were identified and evaluated. These four survey engines included MicroSURV, Sawtooth, atSURVEY, and RaoSoft each of which are reviewed below.

Following the review of commercial systems is an overview of government- developed and -owned software.

MicroSURV - A review of recent catalogs of major test and job analysis publishing firms (Consulting Psychologists Press, 1994; The Psychological Corporation, 1994) indicates that most firms are not currently marketing computer-based job analysis systems; typically their products are pencil-and-paper forms with scanable score sheets (such as Psychological Corporation's new Common Metric Questionnaire). However, the 1994 Catalog for the Assessment Systems Corporation ("World Leader in Computerized Testing") includes announcement of a new system called MicroSURV ("The Microcomputer On-Line Survey System").

This PC-based system is designed primarily for data collection and is purported to have mapping/branching capabilities. It also includes a time/clock feature to document survey time and a cutoff feature to automatically cut off administration. The system can deliver either multiple choice or Likert-type question formats. MicroSURV can handle "up to 400 items" [Assessment Systems Corporation (ASC), 1994, p. 15]; this limitation rules this system out for most occupational surveys, based on the size of typical task lists and background sections. In any case, the system is advertised as "Available Fall '94" and thus is not yet available. Costs are also not yet determined. Equipment requirements for this system are: IBM PC or 100% compatible computer; DOS (3.3 or higher), and 640 Kb RAM. A hard disk is required for questionnaire development. There are some conversion programs available, according to the ASC catalog, which will make ASC DOS-based products useable on MacIntosh equipment (p. 4).

Sawtooth - Sawtooth Software (of Evanston, IL and Ketchum, ID) has fielded a computer-aided telephone interviewing and analysis system, which also has capabilities for adaptive conjoint analysis, adaptive perceptual mapping, and cluster analysis (Sawtooth Software, 1989). Of interest here is their "Disks-by-Mail" system which facilitates data collection by mailing a survey to individuals to be accomplished on their personal or business PCs. The advantages of this system include standard statement of questions (versus telephone interviewing), higher response rates, and little requirement to scan and "clean up" data (Sawtooth Software, 1989, pp. 4-5). Practical considerations include difficulties in deciding the size and density of disks to mail, concern with computer viruses, and potential compatibility problems with some types of monitors and printers. Software for creating surveys is available for purchase (up to 100 variables for $500, up to 1000 variables for $4,000). A "variable" is any possible choice for any question; thus the 1000 variable upper limit may be a problem for accomplishing military occupational surveys, which contain large numbers of background items in addition to 300 - 1800 tasks. Purportedly, the source code for the "Disks-by-Mail" and clustering programs could be made available to the government for $25,000 for modification and use (Sawtooth letter to Mr. Walter Albert, 1991).

atSURVEY - Another commercially-available, computer-based survey system, and one designed specifically for the task-based approach of job analysis, is the atSURVEY system. atSURVEY is an ancillary product associated with atCODAP, a micro-computer based version of CODAP, developed by Sensible Systems, Inc. of San Antonio, Texas (Staley, Weissmuller, Lewis, & Johnson, 1987; Weissmuller, Staley, Lewis, & Johnson, 1987). atSURVEY has been tested on a variety of DOS-based platforms (see Sage, 1993). The atSURVEY system was employed recently, using 3.5" 720 Kb disks which were mailed to 14,000 Ford Motor Company engineers in North America and 5,400 engineers in Ford's European Automotive Operations. This was a very successful application which resulted in meaningful data for use by Ford management to identify training requirements (Tsai, 1993, p. 12). A site license for atCODAP is $50,000 for the first year with $5,000 renewal for each subsequent year. This atCODAP license with all standard analysis capabilities (such as interrater reliability, case/task clustering, job descriptions, etc.) includes an unlimited world-wide license for atSURVEY.

Because the atSURVEY system is used for occupational analysis, it offers a reasonable template for reviewing the entire automated survey process. The atSURVEY system is divided into five phases.

Phase One: Survey Creation - Phase One involves actually creating the inventory. atSURVEY accepts flat ASCII files from any word processor/text editor as well as input from standard sources such as ASCII CODAP (Unisys, VM, MVS, RISC), FIELDATA CODAP, IBM CODAP 360, CODAP/OSA (Occupational Surveys Australia, LTD, Unisys), and TIARA. When inputting text or converting and modifying previous inventories, a suite of audit programs is available to ensure proper format prior to mastering a survey disk.

Phase Two: Disk Mastering - Phase Two is the mastering of a survey disk. When located in the directory with the text files describing the inventory, insert a freshly formatted diskette and type "atDisk A:" or "atDisk B:" to create a Master on the desired drive (and disk format).

Phase Three: Disk Reproduction - Reproducing the master disk in the proper quantities and proper sizes (5.25" x 360Kb; 5.25" x 1.2Mb; 3.5"x720Kb; and 3.5"x1.44Mb) is required. Orders for 500 to 5000 disks are typically reproduced and returned within four days. Costs run around $1.00 per disk with customized professional labels adding about $0.04 per disk.

Phase Four: Survey Administration - This phase involves targeting, shipping, local distribution/collection (if desired), return shipping, and return shipment inspection and log-in of actual survey disks.

Phase Five: Data Aggregation - Data aggregation includes preliminary quality control, data base initialization (selection of a target hard disk directory), and incorporation of contents from each disk using the atLOAD program. atLOAD produces an atCODAP-ready data base. A conversion program, EXPORTCD, converts the atCODAP Case Data File into ASCII CODAP, card-image format.

Discussion - Although the U.S. Coast Guard (USCG) is a licensed user of the atCODAP system for inventory development and analysis of data, the USCG has not yet attempted automated survey administration (Lanterman, personal communication, 24 May 1994). Their internal PC capability uses a unique operating system which is not compatible with DOS or MacIntosh systems. Ultimately, the USCG occupational analysis program would prefer PC survey administration, with inventories and specific individual responses transmitted by E-mail (Lanterman, personal communication, 24 May 1994).

Licensed use of the atSURVEY system by itself can be obtained from Sensible Systems, Inc. for a fee of $1.00 per-disk; this does not cover any costs to set up the inventory or reproduce the disks. This fee permits Air Force (or IJOA) personnel to use the necessary software required to survey the number of individuals contracted. A program, EXPORTCD, permits the reformatting of the final data base (from atLOAD) for use in ASCII CODAP (Unisys, VM, MVS, or RISC).

RaoSoft Survey - In 1994, the U.S. Army occupational survey staff began the "reengineering" of the Army Occupational Survey Program (AOSP), now retitled as the Occupational Data Analysis, Requirements, & Structure (ODARS), at the direction of the Army Research Institute (ARI), to which the AOSP is now assigned (Worstine, 1995). The use of this commercial software (about $300 per copy; $395 for site license which allows for data collection on disks (p. 118) appears to be focused on obtaining training evaluation data for the various Army schools, rather than full field task inventory administration for multiple users. This new impetus appears to be a result of ODCSSPER or ARI mandate that survey time (survey development and field data collection) must be reduced to six months (p. 97).

While the RaoSoft system has a number of attractive features, it presently does not have the capability to reformat data into CODAP standard input files, process the typically large task data sets, nor meet the requirements for field administration flexibility directed on the present feasibility study. Under a recent Army procurement, RaoSoft Incorporated will add case clustering and inter-rater reliability capabilities to their software for the ODARS Phase IB Test (Worstine, 1995, p. 107).

Review of Government-Owned Survey Administration Software

Because of unique research requirements, the government has developed a series of software systems which successively approach the requirements for a deployable survey admin capability.

Project LAMP's DRIVER Program (1981) - The first such system was the "DRIVER" system for Project LAMP (Learning Abilities Measurement Program). This system was designed to have "drop-in" task lists and used a high-level authoring language. One could easily specify variations from screen colors to total session protocol. As the system was used to measure the learning ability of incoming Air Force recruits, the "users" were assumed to span from total computer illiterate to hacker.

Experimental Scale's Computer-Administered Surveys (CAS, 1991) - For the purposes of the present study, such a government-created software system was already under development in a recent AL/HRMJ computerized survey software and scaling project (Albert, et al., 1993; Phalen & Mitchell, 1993). A large-scale data collection effort was completed at Lackland AFB, TX. These data have been analyzed and a final report drafted (Dittmar, Hand, Tucker & Weissmuller, 1995). The software system used in this project required a hard disk in order to hold three floppy disks of programs for each individual.

Computer-Administered Occupational Surveys (CAOS, 1994) Software - A modified version of CAS was developed specifically for the present study. The CAS software was modified to use only the traditional time-spent scale and could be executed from a single double density disk. The USAF Job Inventories for two AFSs for this study were programmed into the modified software.

Functional Relationships's Occupational Analysis Surveys (OASurv, 1995) - A second Air Force-owned survey system was deployed in November 1995 for data collection under another task. This system, the Occupational Analysis Survey System (OASurv), is drawn from the same source code library, Computer-administered Surveys (CAS), that CAOS used as its starting point. OASurv complies with the original design principles which targeted potentially novice users, while CAOS moved in the direction of advanced features for more computer-literate users. The OASurv model is considered more appropriate for operational AF occupational analysis.

The Present Feasibility Study

A key issue in the feasibility study was to determine the extent to which operational units within the Air Force could support computer-based data collection. That is, how available are personal computers (PCs) in the operational Air Force to support administration of the surveys. Further, are there sufficient computers which would be available to support computer-based occupational surveys. A second issue was the extent to which currently available commercial computer-based survey software packages could be used for the survey.

Determine Current Field Hardware and Software Capabilities

Clearly, if PCs were not available at most Air Force locations or units, the widespread conduct of computer-based occupational surveyings would be severely limited. In addition, if computers were only available at limited sites, then Air Force-wide surveying may not be practical today. Moreover, if military or civilian software was already available which would serve as an operational system, then no adaptation or modification would be needed to operationally implement computer-based surveys. If civilian software for such a use already existed, examination of the costs and time involved could serve as a baseline against which any new system or software could be assessed.

Assess Computer Availability (Hardware) - A survey was developed to determine existing resources available to support computer-based occupational surveying. The results from this survey were analyzed in terms of the overall potential for conducting computer-based occupational surveys.

A pilot test was also conducted at a few AF bases within or near San Antonio, Texas prior to mailing diskettes world-wide. Personnel from AL, AFOMS, and IJOA visited these bases to observe the administration of the surveys. Based on the results of the pilot test details (see Section 4.0), several changes were made to improve usability of survey diskettes and several procedures were modified prior to the main feasibility study.

Availability of Commercial Computer-Based Job Survey - A thorough review of the literature was completed to identify civilian job analysis systems which use PCs for survey administration. A preliminary review of the area indicated that computers are often used for analysis of data, typically scanned from optical or mark-sense score sheets, or for interfacing with a cumulative data base or set of norms, as with the PAQ/PMPQ Enter-Act system (PAQ

Services, 1990), which permits generation of norm-based individual and group analysis reports. Other job analysis systems, such as the Fleishman Job Analysis System (F-JAS), use scanable score sheets and suggest that computer administration will be developed sometime in the future (Fleishman & Reilly, 1992). Other software, specifically designed for computer surveying had to be examined in more detail.

Government Ownership of Software

It was preferable to use government-developed or -owned software for this study, as noted earlier. Issues of site licensing, limitations of existing software, and proprietary rights, in the short time frame planned for the study, made it impossible to properly test other available commercial software. In addition, only with Air Force-owned or -developed software could an operational program be implemented that would be flexible enough to incorporate future software enhancements, as they became available from government research and development programs or from other sources.

Candidate Career Fields for Study

A number of career fields were considered for study. Criteria for consideration were (a) recent USAF Job Inventories completed, (b) Job Interview being currently administered in the field, (c) significant populations at sites in the CONUS, USAFE, and PACAF, and (d) sufficient population sizes for study. In one or both AFSs, it was possible that some individuals might take both forms and, if so, these would be compared as Time 1 - Time 2 samples for reliability (stability) assessment. However, one or both AFSs had to be of sufficient size so that a new random sample could be generated to survey about 800 - 1,000 cases.

The two career fields chosen for the study were: 1) AFS 3A0X1 (formerly 702X0), Information Management, and 2) AFS 2A6X4 (formerly 454X3), Aircraft Fuel Systems. Based on findings from the survey of computer availability, it was expected that PCs would be readily available to most individuals in the Information Management area, since their work normally involves computers, but not as accessible for the Fuel AFS, who work predominantly in a flightline environment. In addition, because both AFSs were spread widely across the Air Force, some generalizability of results was expected.

Review and Debug Computer-Based Job Inventories

Experimental survey software was adapted for the study. Electronic versions of the Job Inventories used in the paper-and-pencil field administration were provided by the AFOMS. The Task Inventory Analysis Requirements Application (TIARA) system files for both AFSs included background sections as well as the actual task lists. The task lists were directly uploaded and edited, but background questions had to be hand entered and formatted.

In addition, Task Difficulty (TD) and Training Emphasis (TE) ratings were collected via computer. Separate TE and TD samples were also generated, with minimum overlap with the traditional paper-and-pencil administrations.

Selection of Random Samples of AFS Personnel

Random samples of personnel to receive the computer-based method were selected. This was done through merging and matching sample files from the paper-and-pencil distribution of each survey with the latest Uniform Airman Record (UAR) files to develop comparable samples for computer-based survey administration. Where possible, individuals receiving the paper-and-pencil versions were purposefully omitted from the computer-based survey; however, in the smaller AFS (Fuels) some overlap was necessary.

Once samples were selected, the AFOMS mailed electronic versions of the surveys and a packet detailing procedures for completing the surveys. An E-mail message was sent from AFMPC to SCMs involved in the test, requesting their participation and explaining the nature of this feasibility study. This kept the objectives of the test open and above board, and helped SCMs observe and report logistical problems/issues which occurred during this special field administration.

Uploading Data and Analyze Results

Upload Data - Upon receipt of completed disks from the AFOMS, IJOA personnel compiled the data into separate AFS files and uploaded the files to the AFOMS computer. Some new software was developed to accumulate individual case data from single disks into a common data file for each AFS, and a special program reformatted the data into ASCII CODAP standards.

Collect Data on Logistical Issues/Problems - In addition to having SCMs administer the computer-based surveys, they were also asked to identify difficulties or problems they encountered (which differ from their normal survey administration activities), how they thought participants accepted this different type of data collection, and any recommendations they might have concerning the potential operational implementation of a computer-based survey system. Some of these questions paralleled items asked in the follow-up survey included on all survey disks, but aimed to acquire the SCM perspective on the system, particularly through open-ended comment and suggestion items.

These data, as well as feedback from AFOMS personnel, served as a basis for identifying critical issues for operational implementation of a computer-based survey system. Time estimates, mailing costs, and other relevant information were developed from AFOMS estimates, to serve as a baseline for comparing the relative cost effectiveness of such a new system.

Analysis of Data Equivalence - A key issue in this feasibility study was whether or not computer-based survey data collection was functionally equivalent (not necessarily identical) to data collected via traditional paper-and-pencil methods. One criteria was the distribution of cases across job types/clusters in a joint Comprehensive Occupational Data Analysis Programs (CODAP) diagram. If cases are randomly generated and data collection equivalent, then computer-based survey cases should be distributed in all jobs, and should not cluster just with themselves. That is, the presence of a job type/cluster totally composed of computer-based

survey respondents would suggest that data collected via this method would not be functionally equivalent to paper-and-pencil collected data. Conversely, relative random distribution of computer-based cases across the job types/clusters of a joint diagram would seem to substantiate that the data are probably functionally equivalent.

In addition, analysis of follow-up survey questions asked of computer-based survey respondents was analyzed to determine respondents attitude towards the computer-based survey process. Responses of members of the two AFSs involved were compared, to determine if there were AFS-specific differences in how personnel reacted to computer-based surveying. One would expect that Information Management personnel would have less difficulty with, and more acceptance of, computer-based survey procedures, since they use computers in their day-to-day work. Aircraft Fuel Systems personnel, on the other hand, might have more difficulty with or be less comfortable with computer-based surveying due to their presumed lack of ready access to PCs.

Document Feasibility Study and Make Recommendations

The study plan also required that activities conducted under this feasibility study would be documented, and that, on the basis of the results analyzed, the study team would develop recommendations for future computer-based occupational surveys in the Air Force (and by extension, the other military services). The documentation would be in the form of a final technical report of the project.

Logistical issues must be highlighted, particularly the relative costs of paper-and-pencil surveys versus computer-based data collection. While not totally comparable, a cost-per-copy would be calculated as a prime comparison figure.

Recommendations were also to be made with regard to how computer-based surveys might best be generated, and to the operating systems ("engines") which might be most efficient.

Pilot Test

Prior to final AF distribution, a small pilot test of the computer-based occupational survey system was conducted. The pilot test was conducted to preclude any major difficulties with the subsequent full-scale field administration.

Initial Pilot Test Results

The pilot test was conducted at four Air Force Bases (AFBs) in Texas: Brooks AFB, Kelly AFB, and Randolph AFB in San Antonio, and Laughlin AFB in Del Rio. Eighteen personnel performing duty in Air Force Specialties (AFSs) 2A6X4, Aircraft Fuel Systems and 3A0X1, Information Management were selected to participate in the test. These personnel were asked to complete Job Inventory or Task Difficulty surveys. The floppy disks containing the survey programs were hand-carried to Survey Control Monitors (SCMs) at Brooks, Kelly, and Randolph AFBs and mailed to the SCM at Laughlin AFB. SCMs then distributed the disks to unit training managers who distributed the disks to survey participants. In most instances, the floppy disks were returned to the SCMs and picked up by a member of the IJOA. A total of 17 surveys were completed and returned; one individual at Kelly AFB had just retired and was not available to participate. This represents a 94% return rate, which is as good or better than normal AFOMS sampling for most specialties.

Seven verbal recommendations were made by SCMs and survey participants. The SCM at Randolph AFB recommended color coding be used to distinguish between the various types of surveys. One survey participant at Randolph AFB made two recommendations: 1) enable comments to be made about tasks when completing Task Difficulty surveys, and 2) add questions designed to solicit opinions about the CAOS program at the end of all surveys. At the time of the pilot test, comments about tasks and the CAOS program could only be made in the job inventory surveys. The SCM at Brooks AFB recommended the surveys be made available on 3.5" floppy disks, since the majority of PCs at Brooks have 3.5" disk drives and these disks are not as delicate as the 5.25" disks. Another survey participant at Randolph AFB suggested incorporating the capability to use a mouse during survey administration. Yet another survey participant at Randolph AFB recommended policies be changed to require survey administration in a controlled environment. This participant completed the survey in his duty section and was constantly interrupted by phone calls and members walking into his section seeking assistance.

Written comments received from personnel completing surveys are shown below. A feature to display names and telephone numbers of survey participants has been incorporated. This information was not previously available to occupational analysts.

Example Comments

Comments Received from Participants in AFSC 2A6X4
A433 is J. SMITH
A433 1- 1: 14 DEPOT LEVEL AIRCRAFT FUEL SYSTEMS JOURNEYMAN
A433 1- 1: 45 THERE ARE NO INSPECTIONS TO BE PERFORMED ON AIRCRAFT AT _____ AFB. THE ONLY INSPECTIONS DONE ARE FOR DAILY USE ON POWERED AND NON-POWERED AGE EQUIPMENT.

Comments Received from Participants in AFSC 3A0X1
A078 is K.ANONYMOUS
A078 1-1:14 OPERATIONS
A078 1-1:28 SUPERINTENDENT, PROGRAMS & OPERATIONS
A810 is G.HERMES
A810 1-1:22 MY 3A071 SKILLS ARE USED SPARINGLY, MOST OF MY JOB IS HANDLING ANY COMPUTER PROBLEMS THAT OCCUR.
A810 1-1:24 THE JOB I DO IS VERY IMPORTANT TO MY ORGANIZATION, IT CUTS DOWN TIME OF COMPUTERS BY 90%. MY JOB IS VERY SATISFYING
A810 1-1: 33 NEED TRAINING ON COMPUTER TROUBLESHOOTING, AND HARDWAREINSTALLATION
A813 is U.SAM
A813 1-1:21 INFORMATION MANAGEMENT HAS BEEN GOOD TO ME BUT I'M READY FOR CHANGES. I DON'T WANT TO SOUND LIKE INFO MGT IS A BAD CAREER FIELD BUT I'M READY FOR CHANGE--I'M PRESENTLY SEPARATING AND TRYING FOR A MEDICAL SLOT IN RESERVE
A813 1-1 : 32 THERE IS AN ERROR IN THE WORDING OF MY QUESTION: I DO HAVE NOT.....
A813 1-1:33 I AM VERY KNOWLEDGEABLE IN MOST OF THESE COMPUTER AREAS FROM SELF-TEACHING AND OTHER PEOPLE WHO HAVE THE EXPERIENCE.
A813 2-1:4 I AM ALL FOR THE COMPUTER-ADMINISTERED SURVEY BUT MAYBE I SHOULD HAVE TAKEN THE SURVEY IN A PLACE OTHER THAN MY OWN OFFICE -- TOO MANY INTERRUPTIONS
A813 2-1:9 THERE WAS NO WAITING BECAUSE I USED THE COMPUTER ON MY DESK BUT AS STATED EARLIER--WHEN MY CO-WORKERS LEAVE THE OFFICE I HAVE NO CHOICE BUT TO ANSWER THE PHONES AND HELP CUSTOMERS-IT TOOK ME ABOUT 1 HR TO DO A 30 MIN SURVEY

Color coding, as a way of distinguishing between the various types of surveys, was implemented. In addition, questions to solicit opinions about the CAOS were also inserted at the end of all surveys. The use of 3.5" floppy diskettes will be considered for possible future surveys of additional AFSs. One criterion for the pilot test was to ensure surveys could be administered on all existing Air Force personal computers (PCs). Therefore, 5.25" low density diskettes were used. Since many Air Force PCs do not currently support installation and use of a mouse, this capability was not incorporated.

Pilot Test Findings

Feedback received from participants and observers was both favorable and constructive. Participants indicated the survey programs were easily executed and the instructions and formats made completion of the surveys quite simple. Participants also indicated that surveys administered via the CAOS software required significantly less time than those administered manually. Participants reported two minor errors in the surveys which were corrected immediately following identification.

One difficulty was encountered that invites Air Force scrutiny of existing data control policies and/or procedures. Current policies permitted the disks distributed to participants assigned to the Air Intelligence Agency (AIA) to be hand-carried into AIA facilities but not out of the facilities. Participants were instructed to mail the disks. The costs for mailing the disks within the city of San Antonio exceeded $3.00 per disk. This situation greatly reduces the cost savings to be realized from the use of floppy disks. If this policy stands, recommend participants be scheduled for survey administration outside of the AIA facilities, such as at the office of the SCM or the base Military Personnel Flight (MPF) testing facilities.

Interestingly, there were no instances where survey participants reported that a computer was not available for use in this pilot test. This and the other findings of the pilot test were sufficiently positive that the full field test administration could be initiated.

Full-scale Field Administration

Initial Administration

A total of two thousand two hundred 5.25", double-density disks were produced (1000 job inventories per specialty plus 50 task difficulty and 50 training emphasis questionnaires), at a cost of about $.56 per copy (not including shipping costs). These disks were mailed to Air Force bases and remote locations worldwide by the staff of the AFOMS, using their normal procedures, with a letter requesting quick administration.

Some problems were encountered in the initial field administration. Some disks, particularly task factor rating disks, tended to "freeze up" the system. Telephone contact with survey control monitors at several bases led to identification of two problems; one had to do with the version of MS-DOS available on the equipment -- the software used some MS-DOS 4.0 commands not available in earlier versions. The second issue was one of internal memory required; machines with 512K or less were not capable of executing the survey administration program.

Readministration

The Air Force operations community, through survey control monitors, was notified of a recall of all task factor disks. At the same time, suggestions were received from survey control monitors on possible administrative and system improvements, such as using different colored disks for each type of survey (task inventory, training emphasis, task difficulty) and each AFS. Task factor programs were modified, the follow-on questions added, the revised system reproduced on 3.5" multicolored disks, and disks were remailed to the field approximately 30 days after the recall.

Of the 2,000 job inventory disks, only about 1,900 were actually mailed, since some organizational addresses proved to be obsolete (particularly some of the support bases in Europe for geographically separated units). Also, a decision was made to exempt Lackland AFB from participation since they had participated extensively in the earlier CAS study.

Processing and Uploading

Upon return, all disks were virus checked before any attempt was made to upload data files. Of the 1900 disks mailed, 19 (or 1%) were found to be contaminated with some type of virus. All but one were deactivated and survey data files recovered.

Virus-checked disks were then processed to upload data files to a computer. The upload utility program handled the multiple data files on each disk sequentially; this software was subsequently modified to handle all in an integrated process which included entering the case control number onto the disk. Disks were rejected as unusable if they did not contain key background data and the task inventory responses. Of the 1000 original disks per AFS, 627 cases were successfully uploaded for the Aircraft Fuel Systems specialty (62.7% usable return rate) and 656 were loaded for the Information Management specialty (65.6% usable return rate).

The Task Difficulty and Training Emphasis diskettes, which were initially withdrawn and resent, were returned at a substantially lower rate. In addition, those diskettes which were returned were incomplete and largely unusable. The problem with most diskettes appeared to be the "work around" used to overcome limitations of the survey engine. A different software engine was needed for task factor surveys and, in fact, had recently been developed. In the future, the task factor capability should be incorporated into standardized occupational survey software.

Data Analysis

A variety of analyses were performed on the returned data or restricted subsets of the data.

Time 1 - Time 2 Reliability - For the Aircraft Fuel Systems specialty, there were not sufficient potential participants to avoid duplication between the recent paper-and-pencil survey

administration and the present computer-based survey. This fortuitous situation created a very natural opportunity to assess a repeated measures reliability, at least for those cases where the individual was in the same job (i.e., had not transferred to another unit or changed job title).

The assessment of whether an individual was still in the same job was a subjective one, based on available background data from the two survey administrations. Where an obvious change had taken place (major reassignment or change in duty title), the decision was reasonably clear and the individual was excluded from the reliability assessment. Where no major change was obvious, the individual was included even though the number of reported tasks performed might have changed substantially.

For Information Management, a totally-independent random sample was selected since there was sufficient population available; even in this case, however, a few repeat administrations were found, which provided at least a small sample for Time 1 - Time 2 reliability assessment. For both AFSs, the time interval was 12 to 18 months, versus the usual two to four weeks. The results of these analyses are shown in Table 1 below.

Table 1. Time 1 - Time 2 Reliability

	Aircraft Fuels 2a6x4	Information Management 3a0x1
Number of Repeated Cases	290	31
Number in Same Job Type After 12 - 18 Months	124	11
Range of T1-T2 Correlations	.30 - .82	.38 - .75
Average Fisher Z	.67	.70
Average Number of Tasks At Time 1	175.50	63.80
Average Number of Tasks At Time 2	214.40	92.10
Difference	38.90	28.30
Percent increase	22%	44%

Remarkably, even though the time interval between administrations is quite extended, the range of individual correlations is quite comparable with a series of Time 1 - Time 2 reliability studies accomplished in the early years of task-based military occupational analysis and job analysis studies in general (Sellman, 1968, pp. 244-245; McCormick, 1979, pp. 130-132).

In both AFSs, there was a marked increase in the average number of tasks performed; these increases were much greater than anticipated. While some increase in the number of tasks performed might be a function of job growth over time, we cannot rule out the possibility of some method effect; that is, that this increase may be due, in part, to the use of the computer as the data collection method. Earlier studies contrasting computer and paper-and-pencil

occupational surveys revealed a similar trend with computer-based administration (see Hudspeth, Fayfich, & Price, 1990), but the effect (assessed with a counterbalanced experimental design) was on the order of six to nine percent difference. The differences in both career fields used in this study greatly exceed what would be expected from method effect alone.

One possible explanation for such differences may be the result of having the computer enforce the two-stage rating process, where the individual first checks all the tasks in the task list he or she performs, and then do a second pass through the task list providing a time spent rating for only the tasks reported as performed in the initial pass. With the computer-based survey, this procedure is rigidly enforced; only those tasks checked on the first pass are displayed for the time-rating pass. In paper-and-pencil administration, it is possible for a respondent to check and rate in one pass even though this is contrary to instructions.

This potential explanation deserves further study, preferably with a large sample, well-controlled, counterbalanced experimental design. It may be possible with such an experimental study to demonstrate that computer-based survey administration yields improved occupational data through the structured enforcement of the two-pass, check and rate, system.

In addition, note the difference in the amount of increase between the two specialties involved in this feasibility study. It would be worthwhile to expand and extend the results of this feasibility study by studying more specialties and obtaining enough data to begin to understand whether these are systematic or coincidental findings.

Comparability Analysis - A primary question to be answered in this study is whether computer-based survey administration yields the same or a different picture of a specialty. One way to address this question is to compute the correlation between the overall job description of paper-and-pencil cases for an AFS with the same job description from the computer-based survey. Such correlations could be calculated on the percent time spent (PTS) vector, the percent members performing (PMP) data, or the rank ordering of tasks on the PTS or PMP information (see Table 2).

Table 2. Correlations of Original and CAOS Cases (Facmat)

	Aircraft Fuels 2a6x4	Information Management 3a0x1
Percent Time Spent (PTS)	.97	.98
Percent Members Performing (PMP)	.98	.98
Rank Order PTS	.98	.96
Rank Order PMP	.98	.97
Original N	1145	2442
CAOS N	627	656

The results of these analyses demonstrate that the overall picture of an occupation is the same for computer-based occupational surveys as it is for paper-and-pencil survey administrations, whether assessed using PTS, or rank order statistics. Yet the earlier Time 1 - Time 2 analysis indicated that the computer-based surveys result in more detailed, perhaps more complete job descriptions. Clearly there are more analyses which can and should be done with these data, and more experimental studies are needed to clarify exactly what is happening in the computer-based environment. Additional analyses have been completed comparing job and task clustering results with the different data sets, as well as comparing job-type descriptions for the major job variations. There are no compelling data to suggest that computer-based job data are in any way inferior to paper-and-pencil data. Results indicate that the computer-based survey process is more systematic and consistent.

A second analysis was attempted by comparing the job types analyzed in the initial occupational survey report (OSR) based on the paper-and-pencil survey results with job types found in the subsequent computer-based survey. A comparative analysis of the two surveys separately indicated that all major job types were found in both samples, except for one small job type found only in the paper-and-pencil study (n = 6 cases). Again, it is not obvious whether this change is a result of different sampling (size of samples at the two time periods), the survey method (paper vs. computers), or a real change in the work world being accomplished.

Conclusions - Overall, the results of these analyses are positive and suggest that computer-based surveys are as good as, and possibly better than, traditional paper-and-pencil survey instruments. Job types analyzed will be generally comparable, with the possible exception of small isolated groups who represent only a small fraction of the total population. The more intriguing possibility is that computer-based surveys may, in fact, result in better and more complete results through systematic enforcement of desired survey administration procedures. With no external, accepted criterion against which to assess the two methods, there is no absolute way to demonstrate the superiority of one method over the other.

Logistics and Cost Analyses

Among the major objectives of the study were analyses of the availability of computer equipment and an assessment of the costs and logistical problems involved with computer-based survey administration.

Cost Analyses

To address the cost issues, the costs of the current survey program were examined. On an average, the AFOMS surveys thirty-five AFSs per year, with an average of two thousand incumbents per AFS. The manual design, development, and administration of survey instruments have proven to be very costly. The costs for AFOMS to print a single survey instrument, in scanable booklet format, ranges from $3.00 to $10.00, depending on the format and the size of the booklet. For example, the Fiscal Year 1995 budget for printing the occupational survey instruments required to support thirty-five surveys was approximately $300,000. This budget paralleled the actual cost during Fiscal Year 1994. The typical cost for mailing a single average survey booklet to a field location is $520. At current rates, the approximate cost to mail booklets for the 35 surveys conducted annually would be $18,200. The total estimated costs for printing and mailing survey instruments for our example during Fiscal Year 1995 is $318,200 (excluding the personnel man-hours involved and overhead).

Table 3. Comparison of Annual Survey Costs (based on 35 surveys per year)

	Production	Mailing	Total
Paper-and-Pencil Surveys	$300,000	$18,200	$318,200
Computer-Based Surveys	$ 39,200	$18,200	$ 57,400
Difference			$260,800

During the feasibility study, two thousand disks were produced at a cost of $1,120, or $0.56 each; this figure includes the cost of labels and express shipment for reproduction of the disks. Costs for mailing the floppy disks were virtually the same as for mailing booklets (within $0.01). The production and mailing costs to support 35 surveys per year would be about $57,400. This represents a potential annual savings of $260,800 each year through the use of computer-based surveys (see Table 3).

Additional savings may be feasible if disks are recycled and if AFOMS can eventually procure equipment to mass produce programmed diskettes. Such savings appear to be highly significant and represent a significant increase in the economy and efficiency of the program. Additional savings will also result from reduction in the time it takes incumbents to complete surveys as well as reduction in the total amount of time required to conduct an occupational survey project (survey development, printing, mailing, data scanning, set up, analysis, etc.). It is

difficult to estimate the latter savings, but they can only add to the impressive savings demonstrated in the cost analysis provided.

Respondent Attitudes and Computer Equipment Availability

Each disk administered in this study also included a follow-up survey to address the availability of equipment and respondents' attitudes toward computer-based surveys.

Attitudinal Data - Survey participants indicated they much preferred the computer-based surveys to the "paper-and-pencil" surveys which they had completed previously (see Table 4). Participants further indicated instructions were easy to follow and programs were easy to operate; few, if any, problems were encountered in their completing the job inventories.

Table 4. Comparison of Respondent Attitudes (percent who slightly agree, agree, and strongly agree)

	Aircraft Fuels 2A6X4 (N = Approx 649)	Information Management 3A0X1 (N = Approx 697)
Little Difficulty Locating Computer?	86%	88%
Computer Functioned Properly?	87%	92%
Instructions Easily Understood?*	77%	82%
Reasonable Amount of Time To Complete?*	41%	57%
Career Field Members Can Complete?*	81%	87%
Prefer Computer Administration?*	65%	72%
Computer Survey Was An Enjoyable Experience?	16%	30%

*Note: in A Recent U.S. Army ODARS Study (Worstine, 1995), Members of Three Military Occupational Specialties Were Asked Similar Questions, With Comparable Results, Concerning Completion of Computer-Based Training Evaluation and Task Performance Surveys.

Perhaps the most significant result in Table 4 is the comparability of responses between the two specialties, as opposed to the expected lack of availability of equipment or computer capability of the more operational AFS (Fuels). An overwhelming majority of job incumbents in both specialties had no difficulty locating a computer, operating it satisfactorily, and believing that most incumbents in their field could do likewise.

The major differences in the two specialties involve their perceptions of the amount of time to complete, with less than half of the Fuels personnel thinking the time required was reasonable to a majority of the Information Management personnel who felt so. The difference here may be a function of the differing degrees of computer familiarity between the two specialties since Information Management personnel routinely work with computers in most

aspects of their jobs. Obviously, the more flightline-oriented Fuels personnel were not totally happy with the amount of time required, even though their responses on other questions were generally positive.

Only a small number of individuals answered the question related to the computer survey being enjoyable positively. Thus, while job incumbents are able to find equipment, operate it properly, and will provided requested information, we cannot expect them to particularly enjoy it. They do it because it is necessary and important to the Air Force, not for the fun of it.

Equipment Availability - In terms of the equipment available to job incumbents for completing occupational surveys, the data collected are shown in Table 5.

Table 5. Comparison of Computer Equipment Availability (percent responding yes)

	Aircraft Fuels 2A6X4 (N = 649)	Information Management 3A0X1 (N = 697)
Color Monitor	88%	91%
Mouse	41%	43%
5.25" Disk Drive	86%	90%
3.5" Disk Drive	35%	41%

The rather surprising findings in these data are that less than half of the personnel in both specialties reporting having a mouse available on their computers, which infers that most are operating in a non-Windows environment, and that even fewer have a 3.5" disk drive available. Data from the Pilot Test had suggested that 3.5" drives were widely available and were preferred; field data indicates that is not true for some 60 - 75 percent of the Air Force population.

These findings confirm that it was a good decision to use the lowest common denominator system in conducting this feasibility study; that is, 5.25" double-sided, double-density disks as opposed to the more advanced high-density drives. By using the less sophisticated system, more individuals and units were able to participate in the study.

While 3.5" drives, mouses, and high density capabilities are becoming much more widespread in the Air Force, as are Windows applications, there is no universally available hardware system (nor any standard software, even though some organizations have mandated the use of Microsoft Word, Excel, and PowerPoint). There is typically a very long lead time before any standard systems or innovative technologies become available throughout the entire Air Force, simply because it is a very large, geographically and organizationally dispersed organization. For computer-based surveying, these results suggest that for the near future, at least, the use of low-end systems (5.25" DS-DD disks, and non-Windows software) should be continued.

One feasible option is to include instructions with each set of surveys mailed to a base to permit the Survey Control Monitor, or other knowledgeable individual, to copy the survey software locally to 3.5" disks, if that will facilitate rapid data collection (rather than having job incumbents have to hunt for a computer to use). For most AFOMS purposes, it does not matter which type or size of disk is used to transmit data.

Eventually, this issue and potential problems will disappear, as computer surveys are transmitted via other means (milnet, E-mail, internet, etc.), as has been suggested by the U.S. Coast Guard.

Survey Completion Time - The time required for participants to complete computer-based surveys was approximately one half of that typically reported by participants in paper-and-pencil surveys, based on analysis of start-and-stop times recorded on a selected subset of disks (at least two different bases for each AFS). Participants indicated approximately two hours had been required to complete paper-and-pencil surveys. Observations by persons conducting the pilot test and by Air Force personnel during the administration of surveys revealed that, on an average, approximately one hour was required to complete a computer-based survey.

Conclusions and Recommendations

There are a number of further research and development issues which need follow-up action, including the higher average number of tasks performed as reported by the computer-based survey respondents and what that implies for automated job- and task-clustering. There is a typical problem in terms of which result is an acceptable criterion; are we just attempting to replicate the existing data analyses or do the computer-based survey results yield superior outcomes (through systematically enforcing the desired administration procedures)? Additional work is needed to clarify these and other findings of this study.

Clearly, however, it has been demonstrated that deployment logistics pose no major barriers to operational Air Force usage of computer-based occupational surveys, and that major savings are possible, particularly through avoidance of precision printing costs. Minor issues remain in aspects of electronic deployment and data reacquisition (disk mailing vs. E-mail, etc.). This means that attention should now be focused on developing tools to facilitate and expedite automated inventory production. Serious evaluation must be made of the candidate survey programs (software engine) to be used to deliver operational Air Force Job Inventories.

Additional support software is needed to permit integrated virus checking, data conversion (to CODAP standards), and file consolidation. With new tools and supporting methodologies, Air Force occupational analysis appears to be on the verge of a quantum leap in reliability, speed, and cost effectiveness.

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Appendix A

Study 2005 - Aircraft Fuels. AFS2A6X4 (Formerly 454X3)
Time 1 - Time 2 Case Correlations

[Of the total sample, 290 cases matched as Time 1 - Time 2 participants. A review of PRTVAR data indicated that of this number, only 124 were in the same job type after the 14 - 18 month interval between the two survey administrations. Thus, only these 124 are valid Time 1 - Time 2 comparisons in terms of reliability of job information.]

Case	Mean	SD	Ntsk	Correlation
469	.71	1.61	92	
1569	1.14	2.05	136	.67
773	1.06	2.34	108	
1204	.24	1.99	205	.57
303	3.33	3.41	273	
1614	.67	1.32	145	.50
1068	1.68	3.01	144	
1622	1.82	2.76	187	.60
810	1.91	2.22	387	
1730	1.21	1.78	197	.53
738	1.73	2.70	191	
1464	1.77	2.75	211	.66
228	.59	1.33	119	
1361	.52	1.22	146	.63
1056	2.36	2.70	293	
1519	.94	1.32	323	.48
91	.13	.98	11	
1321	.28	1.24	37	.54
372	1.34	2.94	108	
1329	1.55	2.86	137	.64
1094	.80	1.63	123	
1155	.82	1.57	136	.47
254	3.12	2.91	311	
1360	3.94	4.00	298	.59
700	1.50	2.66	167	
1665	4.46	3.55	375	.46
718	1.99	2.51	225	
1679	2.93	2.56	318	.48
955	2.08	3.09	192	
1219	2.52	3.16	264	.66
883	1.10	2.05	152	
1544	1.63	2.14	250	.57
448	.90	1.82	127	

1187	.56	1.16	142	.45
560	1.77	2.65	211	
1158	1.78	2.62	239	.63
855	.83	1.67	126	
1318	.87	1.69	132	.59
458	.86	2.36	75	
1189	1.18	2.13	135	.50
917	1.76	2.07	300	
1301	2.25	2.26	334	.65
563	.93	2.02	113	
1231	1.13	1.88	164	.66
394	1.83	2.49	211	
1257	2.29	2.87	232	.59
172	1.08	2.06	120	
1644	1.36	1.89	205	.49
261	2.14	2.72	227	
149	13.38	3.64	288	.69
990	1.93	2.32	265	
1407	3.04	2.67	326	.51
879	1.36	1.90	204	
1545	.89	1.22	282	.45
959	1.69	2.30	205	
1214	2.76	4.13	180	.56
553	2.20	3.13	202	
1163	2.38	3.08	245	.70
719	2.87	3.05	273	
1466	3.09	2.78	320	.58
734	.99	2.10	115	
1675	1.33	2.18	156	.49
497	2.35	2.56	282	
1689	3.80	3.35	329	.68
904	.49	1.19	119	
1602	.43	1.14	117	.66
148	.51	1.72	48	
1324	1.76	2.58	186	.41
701	.98	2.07	112	
1248	.74	1.72	96	.51
737	1.44	2.64	140	
1390	1.90	2.91	181	.67
721	.63	1.49	138	
1676	.78	1.05	317	.58
741	1.28	2.47	132	
1468	1.26	2.20	137	.51
722	2.49	3.26	227	
1477	1.77	2.39	244	.57

158	1.09	2.07	135	
1353	1.71	2.38	189	.61
68	2.65	2.58	287	
1276	1.84	2.33	222	.45
296	.99	1.88	151	
1449	1.38	2.16	192	.59
740	1.59	2.49	188	
1673	2.09	2.46	234	.57
41	1.11	2.06	126	
1538	2.27	3.30	191	.64
728	1.44	2.54	160	
1674	1.60	2.38	259	.60
569	2.30	3.28	238	
1391	2.29	3.06	241	.72
872	1.72	2.45	224	
1541	.89	1.35	249	.65
716	2.21	2.57	268	
1648	1.84	2.44	202	.51
950	1.60	2.56	195	
1217	2.11	2.45	284	.63
360	.92	1.90	121	
1311	1.55	2.78	156	.64
1129	1.82	2.21	236	
1394	2.12	2.03	305	.58
440	.81	1.69	118	
1552	.81	1.37	155	.45
464	1.13	1.80	156	
1198	2.54	3.04	318	.48
822	2.58	3.05	287	
1306	2.62	2.81	314	.82
570	2.70	3.12	256	
1442	1.90	2.28	244	.77
657	1.48	2.40	163	
1151	1.55	2.22	191	.71
688	2.08	2.95	210	
1749	1.27	2.05	193	.62
53	1.45	2.08	201	
1654	1.82	2.38	214	.67
173	.95	2.07	113	
1597	1.64	2.36	212	.55
1126	2.15	2.56	244	
1511	1.74	1.81	320	.62
237	1.91	3.00	169	
1337	1.18	1.85	183	.74
67	1.12	2.64	88	

1478	1.12	2.55	102	.66
858	1.07	1.86	166	
1315	1.85	2.12	304	.32
152	1.75	2.65	185	
1317	2.23	2.36	295	.57
770	1.32	2.45	147	
1734	1.86	2.15	310	.42
272	1.03	2.07	112	
1566	1.58	2.40	174	.53
24	1.73	3.23	134	
1695	1.41	2.31	165	.58
153	.88	1.79	175	
1352	2.43	2.56	316	.51
504	1.25	2.02	170	
1254	1.38	2.16	190	.41
1022	1.86	2.59	205	
1550	2.17	2.45	271	.65
60	2.27	3.00	231	
1458	2.60	2.84	268	.56
1076	.85	1.77	109	
1711	1.41	2.15	176	.64
255	5.35	3.33	428	
1362	3.66	2.48	398	.45
457	3.28	3.93	227	
1568	1.81	2.45	197	.55
929	1.77	3.35	137	
1175	1.57	2.52	215	.70
739	1.52	2.49	167	
1747	2.13	2.48	236	.59
705	1.57	2.40	171	
1669	2.20	3.28	199	.62
64	2.29	2.46	266	
1661	2.48	2.43	306	.59
59	3.08	3.81	232	
1643	1.91	2.42	232	.63
842	1.50	2.27	174	
1416	1.60	2.33	196	.50
947	1.17	2.26	144	
1179	1.61	2.73	176	.67
177	1.72	3.25	128	
1457	2.44	3.67	190	.51
1090	1.89	3.15	168	
1523	3.34	3.47	307	.60
47	1.28	1.82	218	
1662	1.61	2.32	186	.71

290	2.43	3.64	174	
1645	2.29	3.18	289	.51
949	2.03	3.27	165	
1216	1.46	2.79	133	.70
169	3.14	2.43	520	
1455	2.36	2.59	263	.44
826	1.21	2.38	157	
1296	1.67	2.08	280	.54
298	.40	1.30	60	
1447	1.79	2.40	198	.30
133	1.81	2.49	228	
1471	2.14	2.62	237	.53
147	1.78	3.11	154	
1340	1.77	2.93	203	.61
77	.68	1.56	112	
1556	.59	1.63	121	.71
925	2.01	2.62	236	
1180	2.59	2.92	254	.69
140	1.04	1.92	140	
1561	1.64	2.69	184	.61
308	1.74	2.24	234	
1703	1.89	2.60	221	.52
1041	.41	1.44	66	
1336	.49	1.61	55	.46
1145	1.13	1.83	173	
1192	1.92	2.30	239	.67
752	1.11	2.05	160	
1726	1.75	2.47	203	.34
652	.65	1.46	130	
1721	.85	1.64	161	.65
287	.11	.72	13	
1612	.59	1.76	59	.45
30	1.01	2.15	120	
1768	1.55	2.25	197	.59
840	1.65	2.39	217	
1759	2.06	2.79	254	.57
5	1.59	2.29	192	
1548	1.81	2.53	230	.58
653	2.30	2.89	255	
1156	2.00	2.29	264	.59
757	1.27	2.24	140	
1402	.67	1.90	64	.60
717	.60	1.37	134	
1465	.59	1.28	142	.57
154	1.58	3.00	140	

1342	2.03	3.18	188	.63
121	1.08	2.43	120	
1598	1.78	2.51	196	.46
540	.58	1.57	69	
1147	.95	1.68	140	.44
253	.75	1.96	86	
1359	1.08	2.25	130	.47
811	2.00	2.37	256	
1717	1.03	1.52	228	.51
75	.25	1.15	27	
1234	.27	1.27	25	.73
422	1.25	2.42	147	
1166	1.81	2.52	197	.65
397	2.97	2.65	329	
1251	2.10	2.23	291	.67
165	1.01	2.13	123	
1641	2.38	2.67	263	.46
279	2.06	2.47	240	
1733	2.50	2.74	292	.52
747	1.41	2.34	179	
1558	1.75	2.32	211	.65
792	1.10	2.18	129	
1705	1.81	2.60	216	.64
544	.31	1.35	35	
1229	.26	1.35	26	.67
748	1.00	1.97	118	
1687	1.19	1.89	177	.68
820	.22	.83	62	
1366	.34	1.13	68	.53
931	1.74	2.32	209	
1183	2.53	3.20	251	.64
252	2.33	2.47	263	
1358	2.17	1.90	335	.58
936	1.29	2.37	155	
1173	1.65	2.35	272	.67

Range:	.30 -.82
Average Fisher Z for 124 correlations:	.67
Mean number of tasks, Time 1:	175.51
Mean number of tasks, Time 2:	214.40
Difference	38.89

(= 22% Increase in Average Number if Tasks Performed)

Appendix B

Study 2006 Information Management, AFS 3A0X1
Time 1 - Time 2 Case Correlations

[Of the total sample, only 31 cases matched from Time 1 to Time 2. The time interval was from 12 to 18 months between the two administrations. Review of background information, such as number of personnel supervised, job title, base and unit of assignment, etc., revealed that only 11 of these 31 cases remained in the same job type and thus were a suitable sample for assessment of the stability of job descriptions.]

Case	Mean	S.D.	Ntsk	Correlation
195	.14	.78	30	
2697	.06	.56	15	.61
2001	.86	2.35	90	
2490	1.81	2.79	224	.57
1008	.91	2.10	117	
2717	.90	1.92	129	.55
2403	.51	1.61	67	
2532	.59	1.68	80	.43
725	.40	1.46	69	
3010	.72	2.00	97	.73
1247	.23	1.21	27	
2443	.41	1.62	46	.66
1065	.38	1.51	52	
2677	.41	1.42	66	.60
1608	.71	1.92	104	
2608	1.01	2.30	137	.75
469	.34	1.30	60	
2995	.25	1.02	52	.66
929	.30	1.21	55	
2556	.95	2.15	131	.38
1729	.23	1.22	31	
2939	.19	.97	36	.56

Range:	38 -.75	
Average Fisher Z for 124 correlations:	.70	
Mean number of tasks, Time 1:	63.82	
Mean number of tasks, Time 2:	92.09	
Difference	28.27	

(= 44% Increase in AverageNumber of Tasks Performed)